PROJECT FOCUS #10

Small Farm Energy Project

The Young Portable Solar Collector

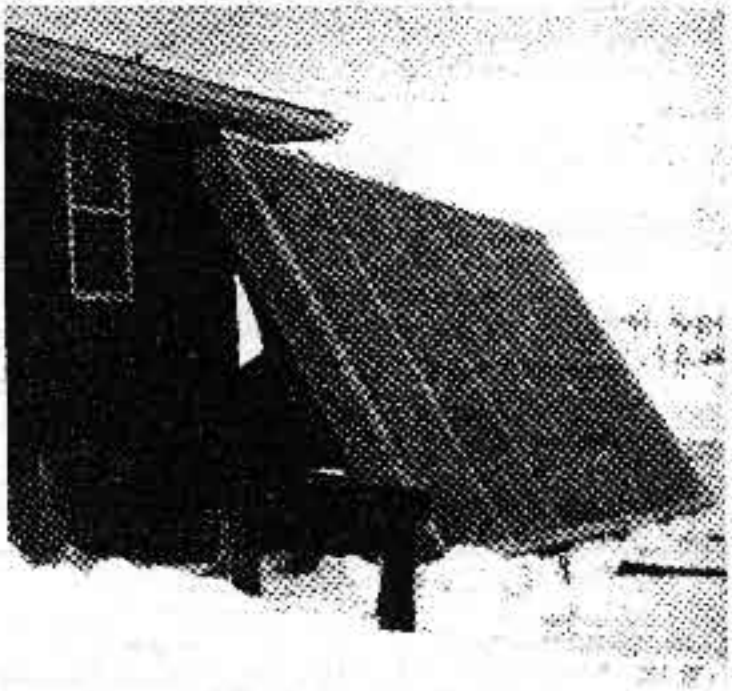
MAY, 1980

The portable solar collector built by Gary Young of McLean, Nebraska has created considerable interest among farmers and others, including some USDA officials. Young has used the unique collector for both grain drying in the fall and space heating of the home during the winter. Since the collector is portable, it is quite flexible as a "multi-use" system. Young designed and built most of the collector himself. "Anybody can build it," says Young. And with much of the construction material recycled, the home-built collector proved considerably less expensive than commercial systems available. The portable collector may not be easily integrated into all farms, or be as cost effective as other options on some farms. But, based on energy savings achieved by the Young collector, it has been a major success for the Young farm and should pay for itself in four or five years.

Development of An Idea

Gary and Delores Young of McLean, Nebr. farm 320 acres in the southwest corner of Cedar County, raising corn, soybeans, milo, oats and alfalfa. Having 5 daughters and a 40-cow diary, they call their farm "Five Queens Dairy". A new dairy barn was built in 1977 and, as cooperators of the Energy Project, Gary and Delores pursued at that time the possibility of using solar energy for water and space heating in their dairy. They sought FmHA financing for a rather expensive commercial solar system, but the loan agency ruled that the system "was not economically feasible," which dampened the Young's solar enthusiasm for a time.

However, in the fall of 1978, Gary Young planned on using a solar vertical wall collector to dry grain in his old dairy barn, which was being converted to store corn. A similar collector had been considered for heating the home, but various circumstances made that difficult. The barn collector was fully designed when Young noticed an ad in a farm magazine for a portable solar collector. Suddenly, the Young solar plans changed again, but this time with increasing enthusiasm. **A portable collector could be used for both drying grain and heating the home.** And since the farm had an old running gear with four good wheels that was no longer used, Young decided that a **home-built collector on the running gear** was what he wanted, especially after he found out that the **estimated cost of the home-built rig was about one-fourth the cost of the commercial system. Young designed most of the portable collector himself, with some technical help from the Energy Project.**



—The 240 sq. ft. portable solar collector built by Gary Young is used for space heating in the home during winter months. Special ductwork is used to move air to and from the basement area through a basement window. Collector cost was about $1300.

Collector Construction

Recycled Materials

Young constructed the 10 ft. X 24 ft. collector over several winter months beginning in December, 1978, during good weather and when he had extra time. **Recycled materials were a key factor on the shopping list.** Besides the trailer, Young had a good supply of used lumber, mostly 2 X 4's and sheathing lumber from an old hog barn, that was useful for the collector.

"It isn't half as hard to build as most people think," notes Young. "Anybody can build it." Young built his collector using common carpentry tools and a welder that he had on the farm.

Unique Features

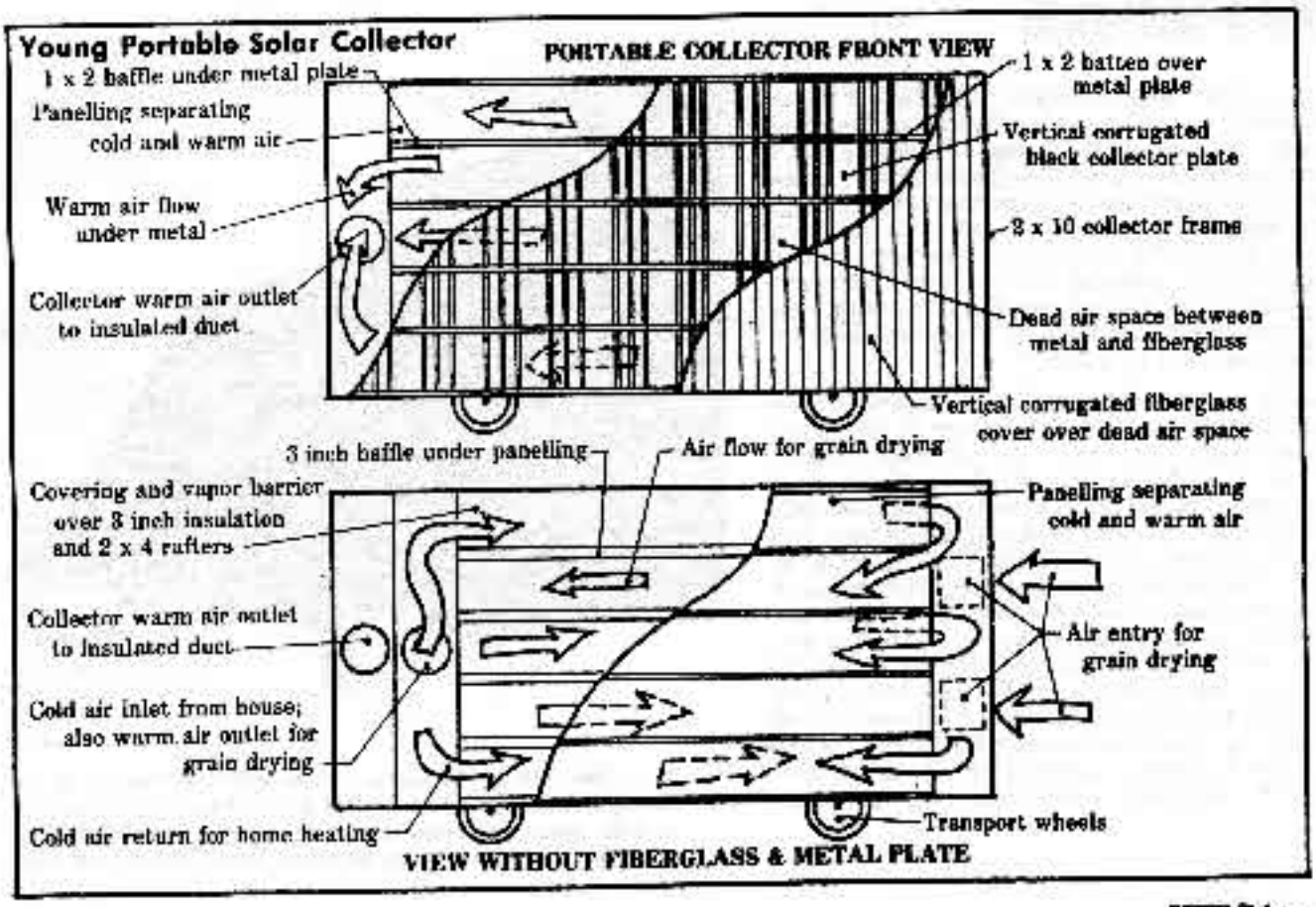
Other essential materials for the collector included **insulated ducts** to move heated air to the home and bring cold return air to the solar collector. A 700 cfm fan (rated at ⅛" static pressure) is used for home heating. A winch, cable and **pulley system is used to change the angle of the collector:** 60 degrees above horizontal for home heating during the winter, 45 degrees for fall grain drying, and 30 degrees for transport. Anchors and cables are used to anchor the collector to the ground when in use in order to avoid wind movement.

The Young collector was one of the first collectors of the Energy Project to **use baked enamel painted corrugated aluminum for the collector plate.** Although the metal is not available in black, the factory baking process insures a good paint bond to the metal. It requires repainting black. Some of the earlier collectors of the Energy Project had used galvanized metal, which is difficult for securing a good paint bond. Another unique feature of the Young system is the **protective weather-proof covering over the insulated ducts** carrying air to and from the collector. An exhaustive search by Energy Project staff resulted in the use of 16" diameter corrugated drain tile for the covering. The material, in 30" lengths, was flexible and easily cut and riveted to desired lengths.

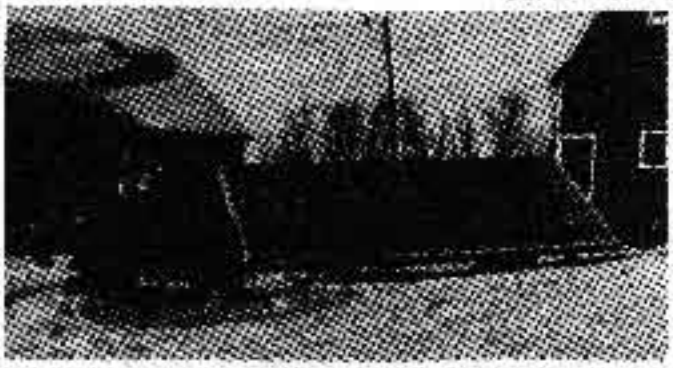
Construction Steps

Young started construction of the portable solar collector by first modifying the running gear. It was lengthened and framed to accomodate hinges and lift equipment of the collector. **Then the 10 ft. X 24 ft. collector frame was built using 2 X 10 lumber.** It was studded out like a wall of a house using old 2 X 4's and 1 inch sheathing. A front-end tractor loader and several neighbors helped with mounting the heavy collector to the transport rig. Then **8½ in. fiberglass insulation was used** between studs, and then covered by a vapor barrier and press plates. Next an air way was made to move cold air from the inlet end of the collector to the opposite end. Young then mounted a layer of wall panelling to separate that airway from the warm airway behind the aluminum collector plate. 1 X 2 lumber was used to form the air gap under the collector plate. Above the collector plate, 1 X 2 lumber was also used to support the fiberglass cover over the metal. The collector was then connected to the house at a basement window. One duct moves cold air to the collector and a second duct carries heated air to the basement. The fan was added in the basement. **A duct is used to direct cold air from the floor of the basement to the collector as the fan pulls air across the collector, moving heat to the ceiling of the basement.**

Young also constructed an adapter for his **grain drying** fan to accept both ducts of the collector. However, in the grain drying mode, a 2000 cfm fan moves more air than in the home heating process, requiring a different air flow. In that case both ducts carry air from the collector to the fan. Young opens air inlets at the opposite end of the collector for outside fresh air to enter. In the future, if Young were to use a larger grain drying fan, he would blend in some outside air at the fan, rather than forcing high volumes of air through the collector, in order to avoid damage to the collector by high static pressure drops.



Collector Operation



—Since the portable solar collector is mounted on wheels, it is easily moved from one location to another. Gary Young uses his collector for space heating in the home during the winter and drying grain in the fall. Such a "multi-use" collector can be more cost effective than other collectors on some farms.

Substantial Energy Savings

The Youngs are pleased with the contribution of solar heat to their home, as Gary described to a community evaluation team of the Congressional Office of Technology Assessment:

"Well, the basement in the house is always cool, not cold, but cool. You can't just sit down there in the wintertime and be comfortable. We have heat down there, but it isn't enough because heat rises, and it just goes upstairs. But putting this on, we just dump all the air into the basement and it makes the basement hot at times, but in order to get away from too much heat, we just open a window and balance it out a little bit."

Even though his portable solar collector afforded the luxury of fresh air in early spring, the **Young's used 265 fewer gallons of propane in 1979 than in 1978,** although the solar collector operated for only four months of the six-month heating season. Because the heating demands of the two years were comparable, the Youngs can expect to realize greater fuel savings in years to come.

Though 1979 was the first year Gary dried shelled corn, he was pleased with his portable collector as a grain drier. While he and other farmers were docked 4 cents/bushel and more at the local elevator for drying costs for each percentage point of moisture over 15.5%, **Young dried 2,000 bushels of his grain harvest from 18.5% moisture content to 15% moisture.** The collector delivered air to his wooden bin at 2,000 cfm with an average temperature rise of 17°F on the calm, clear October days. Relative humidity typically dropped from 62% to 27% after being heated by the collector. Collector efficiency averaged 65% on the clear days of the drying season.

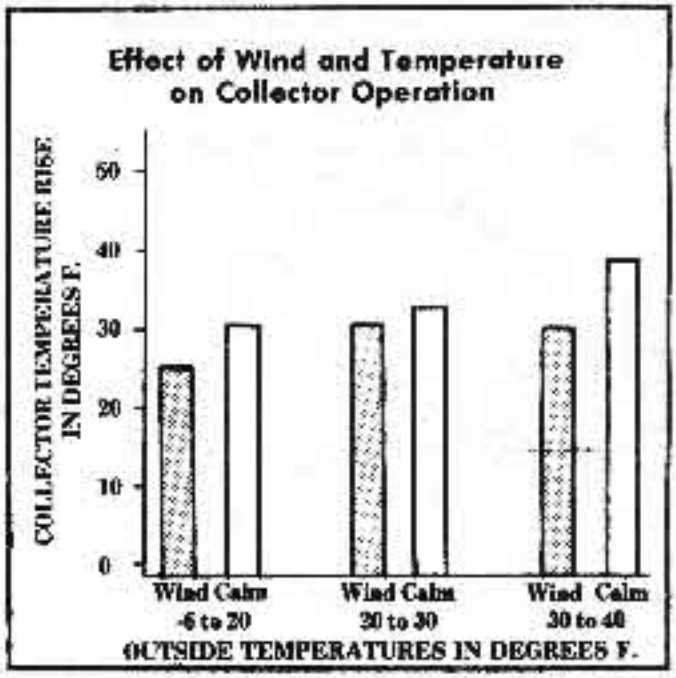
Though his electric bills were $25 more than usual, **Gary figures he saved $275 on grain drying expenses,** based on the local elevator drying charge, for a net savings of $250. **In addition, he saved $105 on home space heating in 1979.** "This year I figure I saved over half," says Young, regarding propane use for heating during the 1979-80 winter.

Collector Monitoring

Young maintained detailed records on the operation of the portable collector. In addition to the temperature of cool air going into the collector and warm air coming out, he monitored the amount of solar energy reaching the collector, the number of hours the collector operated each day, and weather conditions including temperatures, wind direction and velocity, and sky conditions. From this daily journal, a summary of collector operation throughout the seasons of space heating and grain drying use has been prepared.

On days of moderate sunshine (200 Btu/sq. ft.-hr. or more), low temperatures and strong winds reduced the amount of heat delivered by the solar collector. As the accompanying figure shows, the collector heats air over 40°F at noon on calm, clear days when outside temperatures range from 30° to 40°F. On cold windy days (between -6 to 20°F temperatures and more than 10 mph wind velocity) the air is typically heated 24°F at noon.

Heat is lost from the collector during cold and windy weather. To reduce the heat loss, Gary changed the pulleys on the fan to move more air through the collector (from 450 cfm to 550 cfm). With more air absorbing the heat, the collector operates at a lower temperature, resulting in less heat loss. His experiment worked because the collector was operating slightly more efficiently, but the Youngs were not satisfied with the lower temperatures coming from the collector, and returned to use of the original fan speed.



Collector Cost

Portable Collector Cost

Trailer	No Cost
Transport & Collector Lift Equipment	140
Collector, 24 ft. X 10 ft., with Frame	610
Collector Fiberglass Cover with Seals, Filon	140
Ducts and Adapters	260
House Fan and Controls	135
Anchors & Miscellaneous	25
Total Cost ($5.50 per sq. ft. of collector)	**$1310**

After building the portable solar collector himself, **Young notes that he prefers the home-built method for several reasons.** Not only did the system cost him much less than a manufactured system, but Young found that building the collector over several months allowed him a "pay as you build" method of financing the collector from his dairy income, rather than making an investment all at once.

Based on the energy savings of over $300 that the Youngs experienced during 1979 for both home heating and grain drying, **the portable solar collector should pay for itself in four to five years.** Increasing energy prices would of course decrease the pay-back period, as would solar tax credits and other tax advantages for farm solar systems.

Other Considerations

Integrating the Collector to the Farm

One of the key advantages of the Young portable solar collector is that is is a **multi-use collector** and therefore can be **integrated into the farm for various tasks**, like grain drying and home space heating. In some cases, this makes for **a more cost effective solar system** since it is used more days out of a year. However, as with many other energy innovations used by Energy Project cooperators, the nature of the farm will indicate its effectiveness. Some farms can easily make use of the portable unit for several tasks, where other farms will not. Perhaps another farm could find even another use during the summer for some unusual purpose. Therefore **the use of a portable collector is "farm or site specific"** depending on the particular farm in question, and whether or not the collector can be adapted and integrated into the existing farm.

Since the collector is portable, there is flexibility in its use. For instance, a farmer with two grain bins could move the collector from one to the other. For the farmer who is renting a farm, he can build the collector and move it with him, should he rent or buy a different farmstead. Some homes will not easily accomodate a vertical wall collector mounted to the house, and therefore the portable collector may solve the dilemma, with the advantage that the collector can be moved to a shaded area in the summer.

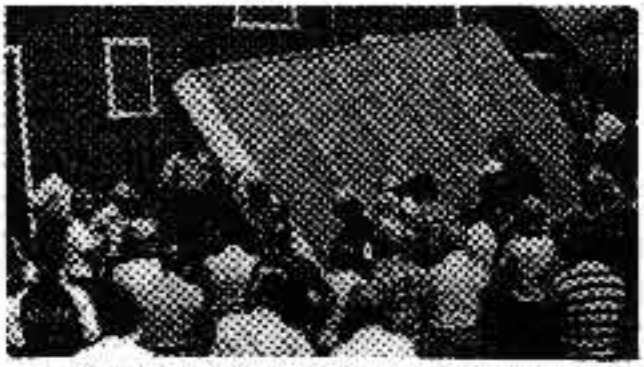
Other Options

With some farms, **it may be more economical to construct a collector onto the home and one onto a grain bin than to build the portable collector.** Since it is free standing, the portable collector is more expensive per sq. ft. than the other collectors, because it requires more structural material. For home heating it also requires insulation. This is not the case with the vertical wall collector, since it is mounted to the insulated wall of the home.

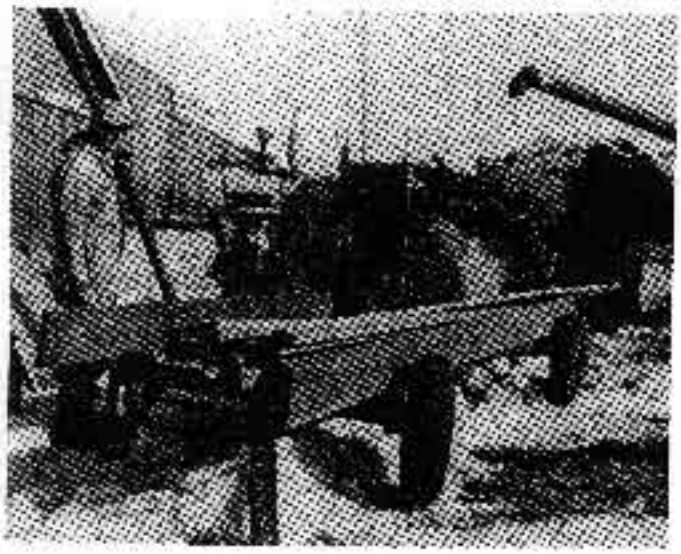
In addition, the vertical wall collector on the home can be more efficient than the portable collector. This is due to the additional heat losses of exterior ducting and more exterior surface area of the collector. The portable unit requires more effort in keeping the system air tight. The Energy Project has monitored the efficiency of the portable collector and vertical wall collectors. As an example, records taken of the collectors during sunny weather between 30 and 40 degrees F. of outside temperature indicate a collector efficiency of nearly 50% for the vertical wall collector, whereas the portable system has shown approximately 90% efficiency in making use of available solar energy, under similar conditions.

If a farmer were planning to use a portable collector for only grain drying and perhaps shop heating, a lower cost non-insulated collector could be used, if it were not used for home heating. Gary Young has also suggested several changes that could be utilized for portable systems. He indicates **that** the collector could easily be mounted on skids rather than wheels, and the angle of the collector could be made permanent to eliminate the lift apparatus. **Other design changes have been incorporated** into plans for the Young collector after construction was completed, **to improve performance.** The detailed plans, including materials list, are available from the Energy Project., for $2.

For the Gary Young family, use of the portable collector has been a successful experience. Gary's resulting enthusiasm for using solar energy led to his construction of **another solar collector onto his dairy barn.** The collector is mounted directly to the south wall for space heating. In addition, Young added a heat exchanger to his milk cooling system for heating dairy water as another energy saver.



—Farmers have been particularly interested in the 240 sq. ft. portable solar collector built by Gary Young of McLean, Nebr. The collector is used for heating the home in the winter and for drying grain in the building, shown above, during the fall.



—Gary Young locates one of the special pipes used to change the angle of his portable solar collector. The above photo also shows the old running gear that Young modified for carrying the collector.

More Information

References

"Portable Solar Air Heater Plans", includes 25-8½ X 11 pages of notes and sketches for the portable collector built by Gary Young for home heating and grain drying. Available for $2 from the Energy Project.

"The Fish Solar Grain Dryer", Project Focus #2, describes 3 solar "wrap-around" collectors mounted onto round grain bins, 6000 bu. and smaller, 50 cents from the Energy Project.

"The Vertical Wall Solar Collector," Project Focus #3, is a another flier on one of the most popular innovations used by Energy Project cooperating farmers. The information describes wall type collectors mounted directly to homes for space heating. Cost is 50 cents.

"Portable Solar Collector", plan No. SP 646 is available for $1 from Dept. of Ag. Engineering, U. of Illinois, Urbana, IL 61801. The 2 page blueprints are for a low-cost 10 X 24 ft. collector for low temperature grain drying or shop heating, but not recommended for home heating.

For More Energy Information

"Project Focus" is published by the Small Farm Energy Project, a research and demonstration project sponsored by the Center for Rural Affairs and funded by the Community Services Administration. For more information, contact the Energy Project, P.O. Box 736, Hartington, Nebr. 68739, phone 402-254-6893.